

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)	
)	
Katsumi Yamamoto)	Examiner: Peterson, Christopher K.
)	
Application No.: 10/603,729)	Art Unit: 2622
)	
Filed: June 24, 2003)	Confirmation No.: 3361
)	
For: IMAGE SENSOR HAVING MICRO-)	
LENS ARRAY SEPARATED WITH)	
RIDGE STRUCTURES AND)	
METHOD OF MAKING)	
)	

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APPEAL BRIEF UNDER 37 C.F.R. §§ 41.31 AND 41.37

Sir:

This is an appeal to the Board of Patent Appeals and Interferences from the decision of the Examiner of Art Unit 2622, which in a Final Office Action mailed February 7, 2008, rejected claims 1-19 in the above-identified application. A Notice of Appeal and Pre-Appeal Brief Request for Review were filed May 7, 2008. A Panel Decision from the Pre-Appeal Brief Request for Review was mailed July 3, 2008, requiring Appellant to submit an appeal brief to the Board. Appellant respectfully requests consideration of this appeal and allowance of the application by the Board of Patent Appeals and Interferences.

It is not believed that extensions of time are required beyond those that may otherwise be provided for in documents accompanying this paper. However, if additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. §1.136(a). Any fees required therefore are hereby authorized to be charged to Deposit Account No. 02-2666. Please credit any overpayment to the same deposit account.

I. Real Party in Interest

The real party in interest in this appeal is OmniVision International Holding, Ltd. ("OmniVision"), a Cayman Islands corporation having a principal place of business at Second Floor, Zephyr House, Mary Street, P.O. Box 709, George Town, Grand Cayman, Cayman Islands, British West Indies. OmniVision is the assignee of the entire right, title and interest in the above-captioned application by virtue of an assignment recorded at the U.S. Patent Office at Reel 014653, Frame 0044.

II. Related Appeals and Interferences

To the best of Appellant's knowledge, there are no prior or pending appeals, interferences, or judicial proceedings that may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of the Claims

Claims 1-19 are pending in the application. No claims have been canceled. Claims 1-19 are finally rejected. Claims 1-19 are the subject of this appeal.

IV. Status of Amendments

Prior to the final Office Action mailed February 7, 2008, claims 1-19 were pending in the application. On May 7, 2008, Applicant submitted a Pre-Appeal Brief Request for Review in response to the Final Office Action but did not amend, cancel, or add any claims. Therefore, all amendments made by Applicants in previous Office Actions have been entered by the Examiner, and the claims on appeal incorporate all previous amendments.

A copy of all claims on appeal, as finally rejected by the Examiner on February 7, 2008, is attached hereto in the Claims Appendix in Section VIII.

V. Summary of Claimed Subject Matter

The claims under appeal generally relate to an image sensor having micro-lenses separated using triangular ridge structures. Claims 1, 8, and 15 are the independent claims under appeal.

Claim 1

Claim 1 is directed to an image sensor having a plurality of pixels formed in a semiconductor substrate. Each pixel includes a light sensitive element. A micro-lens is disposed over each light sensitive element. A raised ridge structure surrounds each micro-lens. The raised ridge structure has a triangular cross-section and at least partially supports the micro-lens such that the micro-lens overlays a base portion of the raised ridge structure.

An embodiment of an image sensor according to claim 1 is depicted in Figures 2-8, which is described in Appellant's Specification at paragraphs [0012]-[0013], [0024], and [0029]. The Specification provides that "image sensor 201 includes a plurality of pixels 203 typically arranged in a two dimensional array.... The pixels 203 typically include a light sensitive element, such as a photodiode or a photogate as two examples.... Formed atop of each pixel 203 is a micro-lens 205. Further, separating the individual micro-lenses is a ridge structure 207.... As will be seen in greater detail below, the micro-lenses 205 are prevented from 'overflowing' (during the reflow process) to the neighboring micro-lenses by the ridge structure 207. The ridge structure 207 may take a variety of shapes the top planarizing layer 403 are [sic] etched away to form triangular ridges 601.... the individual micro-lens are [sic] confined by the triangular ridges after the reflow process."

Claim 8

Claim 8 is directed to a pixel of an image sensor comprising a light sensitive element formed in a semiconductor substrate, a micro-lens formed over the light sensitive element, and a raised ridge structure surrounding the micro-lens. The raised ridge structure has a triangular cross-section and at least partially supports the micro-lens. The micro-lens overlays a base portion of the raised ridge structure.

An embodiment of a pixel according to claim 8 is depicted in Figures 2-8, which is described in Appellant's Specification at paragraphs [0012]-[0013], [0024], and [0029]. The Specification provides that "pixels 203 typically include a light sensitive element, such as a photodiode or a photogate as two examples.... Formed atop of each pixel 203 is a micro-lens 205. Further, separating the individual micro-lenses is a ridge structure 207.... As will be seen in greater detail below, the micro-lenses 205 are prevented from 'overflowing' (during the reflow

process) to the neighboring micro-lenses by the ridge structure 207. The ridge structure 207 may take a variety of shapes the top planarizing layer 403 are [sic] etched away to form triangular ridges 601.... the individual micro-lens are [sic] confined by the triangular ridges after the reflow process.”

Claim 15

Claim 15 is directed to a method of forming a pixel of an image sensor. The method comprises forming a light sensitive element in a semiconductor substrate, forming a top planarizing layer over the light sensitive element, and isotropically etching the top planarizing layer to form a raised structure over the top planarizing layer. The raised ridge structure encompasses the light sensitive element. The method continues by forming a microlens within the interior of the raised ridge structure and over the light sensitive element. The raised ridge structure has a triangular cross-section and at least partially supports the micro-lens. The micro-lens overlays a base portion of the raised ridge structure.

An embodiment of a method of forming a pixel of an image sensor according to claim 15 is depicted in Figures 3-8, which is described in Appellant’s Specification at paragraphs [0014], [0019]-[0020], [0024], and [0028]-[0029]. The Specification provides that a “semiconductor substrate 301 has a plurality of light sensitive elements 303 ... formed therein. FIG. 3 shows the light sensitive element 303 as a photodiode,... Details of forming the photodiode and other associated circuitry are known in the prior art.... a top planarizing layer 403 is formed.... A photoresist layer is deposited over the top planarizing layer 401 [sic] and patterned to leave photoresist ridges 405.... The photoresist ridges 405 should act as a fence for the individual micro-lens to be formed.... an isotropic dry etching... process is performed on the top planarizing layer 403 and the photoresist ridges 405.... those portions of the top planarizing layer 403 that underly the photoresist ridges 405 are etched to form triangular ridges 601.... a micro-lens material is formed over the top planarizing layer 403 and the triangular ridges 601....when developed, gap sections 703 will be removed, leaving blocks of micro-lens material 701, generally over the light detecting elements and between the triangular ridges 601.... As seen in Figure 8, the individual micro-lens are confined by the triangular ridges after the reflow process.”

VI. Grounds of Rejection to be Reviewed on Appeal

Whether claims 1-3, 6, 8-10, 13, and 15-18 are unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 6,043,481 to Tan et al. (hereinafter “*Tan*”) in view of U.S. Patent No. 6,166,369 to Assadi et al. (hereinafter “*Assadi*”). Whether claims 4 and 11 are unpatentable under 35 U.S.C. §103(a) as being obvious over *Tan* in view of *Assadi* in view of Applicant’s alleged admitted prior art. Whether claims 5, 7, 12, 14, and 19 are unpatentable under 35 U.S.C. §103(a) as being obvious over *Tan* in view of *Assadi* in further view of U.S. Patent No. 5,396,090 to Nakai (hereinafter “*Nakai*”). In the following discussion, reference is made to the Final Office Action mailed September 19, 2007.

VII. Argument

Rejection of Claims 1-3, 6, 8-10, 13, and 15-18 Under 35 U.S.C. §103(a)

In the Office Action, the Examiner rejected claims 1-3, 6, 8-10, 13, and 15-18 under 35 U.S.C. §103(a) as being obvious over *Tan* in view of *Assadi*.

The law requires that to establish a *prima facie* case of obviousness, an Examiner must show that the cited references teach each and every element of the claimed invention. (MPEP §2143.) *citing In re Vaack*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)). A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art. *KSR Int’l C. v. Teleflex, Inc.*, No 04-1350 (U.S. Apr. 30, 2007). If a combination or modification to a reference is used, an Examiner must show that there is some expectation of success that the combination or modification proffered would predictably result in the claimed invention. Obviousness is a question of law based on underlying factual inquiries. The factual inquiries enunciated by the U.S. Supreme Court in *KSR* include the *Graham* factors of determining the scope and content of the prior art, ascertaining the differences between the claimed invention and the prior art, and resolving the level of ordinary skill in the pertinent art.

Once the *Graham* factual inquiries are resolved, the Examiner must explain why the difference(s) between the cited references and the claimed invention would have been obvious to one of ordinary skill in the art. The rationale used must be a permissible rationale. The USPTO promulgated Examination Guidelines for Determining Obviousness in View of *KSR* in the

Federal Register, Vol. 72, No. 195 (October 10, 2007). These *KSR* Guidelines enumerate permissible rationales and the findings of fact that must be made under the particular rationale.

It is not clear which rationale is used as the basis for the Examiner's rejection of claims 1-3, 6, 8-10, 13, and 15-18. However, the Court in *KSR* noted that combining known prior art elements is not sufficient to render the claimed invention obvious if the prior art teaches away from combining certain known elements, such as by changing the principle of operation of one or more of the references and/or by making one or more of the references unsatisfactory for their intended purpose, *In re Grasselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983), or the results would not have been predictable if a person of ordinary skill in the art would not have an expectation of success that such a combination would result in the claimed invention. When the prior art teaches away from combining certain known elements discovery of successful means of combining them is more likely to be nonobvious. Moreover, the showing of predictability and/or expectation of success is required no matter which rationale is used.

These long-standing principles, as outlined in MPEP§2143.02, were merely reinforced by the Court in *KSR*. "A rationale to support a conclusion that a claim would have been obvious is that all the claimed elements were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art. (*KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1395 (2007); *Sakraida v. AG Pro, Inc.*, 425 U.S. 273, 282, 189 USPQ 449, 453 (1976); *Anderson's-Black Rock, Inc. v. Pavement Salvage Co.*, 396 U.S. 57, 62-63, 163 USPQ 673, 675 (1969); *Great Atlantic & P. Tea Co. v. Supermarket Equipment Corp.*, 340 U.S. 147, 152, 87 USPQ 303, 306 (1950).") Thus, the burden still remains on the Examiner to demonstrate each prong of the **three-part test**: (1) that each and every element is taught; (2) that one skilled in the art could have combined the references; and (3) that there is predictability/expectation of success.

A. Improper Combination

Assuming for the sake of argument that the Examiner has demonstrated that the combination of *Tan* in view of *Assadi* discloses each and every element, which Appellant is not conceding, Appellant respectfully submits that the combination of *Tan* in view of *Assadi* is

improper. This is because combining *Tan* with *Assadi* makes *Assadi* unsatisfactory for its intended purpose.

In the Office Action, the Examiner states that *Tan* discloses a substrate 12, optoelectronic elements 14 in the substrate, a microlens element 18 over the optoelectronic elements 14, a raised ridge structure 19 surrounding the microlens elements 18, wherein the raised ridge structures 19 at least partially supports the microlens elements 18. The Examiner asserts further that the microlenses 18 overlay a base portion of the raised ridge structures 19 because such an overlay process is inherent in the reflow process of forming the microlens elements 18 between the ridge elements 19. The Examiner concedes the *Tan* fails to disclose a raised ridge structure that has a triangular cross-section, but cites *Assadi* for teaching a reflective structure 12 having a triangular cross-section surrounding a microlens 24. The Examiner then concludes that it would have been obvious to combine the reflective structure 12 of *Assadi* with the image sensor of *Tan* because it would allow more light to be reflected to the microlens for diffraction towards the photosensitive device thereby improving fill factor. Applicant respectfully disagrees.

In the Examiner's Response to Arguments, the Examiner states that *Assadi* is used to show that the ridge elements 19 of *Tan* can be etched in a manner to where the cross section of the ridge is triangular in shape and that for this reason *Tan* in view of *Assadi* teach the elements of the independent claims. Appellant respectfully submits that regardless of the element the Examiner is attempting to combine, the Examiner may not combine them if doing so renders either *Tan* or *Assadi* unsatisfactory for their intended purpose.

It appears that the purpose of the ridges 19 in *Tan* is to separate the microlenses 18 from each other. In *Assadi*, it appears the purpose of the reflective surfaces 12 is to more efficiently diffract incoming light into the pixel 20. The fact that the surfaces 12 are reflective is the operative factor. Any modification that diminishes the purpose of the reflective surfaces 12 in *Assadi* would not be appropriate. That is, if a person of ordinary skill were to combine the ridges in *Tan* with the reflective surfaces in *Assadi* more light **would not** be reflected to the microlens 24 of *Tan*. To the contrary, during the reflow process the microlens would take up space on the reflective surface 12. As a result, **less light** would be reflected to the microlens. This would defeat the purpose of *Tan*, which is to increase the amount of light reflected to the microlens.

Thus because combining *Tan* with *Assadi* would defeat the purpose of *Assadi* discovery of successful means of combining them is more likely to be nonobvious. Appellant respectfully submits that this prong of the three-part test thus has not been demonstrated by the Examiner.

B. No Predictability

Assuming for the sake of argument that the Examiner has demonstrated that the combination of *Tan* in view of *Assadi* discloses each and every element and that the combination of *Tan* in view of *Assadi* is proper, which Appellant is not conceding, Appellant respectfully submits that the Examiner has not demonstrated that modifying the ridge elements 19 in *Tan* to be triangular would predictably result in the claimed invention.

In the Examiner's Response to Arguments, the Examiner never explicitly addresses the issue of predictability. The claim language at issue is the shape of a ridge surrounding a micro-lens. In the Response to Arguments, the Examiner states that *Assadi* is used to show that the ridge elements 19 of *Tan* *can* be etched in a manner to where the cross section of the ridge is triangular in shape. However, predictability concerns *why* a person of ordinary skill would want to form triangular shaped ridges around a micro-lens; the Examiner makes no observation as to why one would want to modify the ridge elements 19 in *Tan* to be triangular. That is, the Examiner has made no finding as to what one of ordinary skill *specifically* would be attempting to improve upon or accomplish by surrounding microlenses with *triangular* ridges. Appellant respectfully submits that this prong of the three-part test thus has not been demonstrated by the Examiner.

C. No Expectation of Success

Assuming for the sake of argument that the Examiner has demonstrated that the combination of *Tan* in view of *Assadi* discloses each and every element and that the combination of *Tan* in view of *Assadi* is proper, which Appellant is not conceding, Appellant respectfully submits that the Examiner has not demonstrated that there had been a recognized problem with the ridge elements 19 or need to modify them using a finite number of identified, predictable potential solutions that one of ordinary skill could have pursued with a reasonable expectation of success.

In the Examiner's Response to Arguments, the Examiner never explicitly addresses the issue of expectation of success. The claim language at issue is the shape of a ridge surrounding a micro-lens. Appellant respectfully submits that the Examiner provides no analysis as to the expectations a person of ordinary skill would have in achieving the technical results that were achieved by embodiments of the claimed invention at issue. Appellant respectfully submits that this prong of the three-part test thus has not been demonstrated by the Examiner.

D. Conclusion

Appellant respectfully submits that in making out a *prima facie* case of obviousness the initial burden rests with the Examiner to demonstrate (1) that each and every element is taught; (2) that one skilled in the art could have combined the references; and (3) that there is predictability/expectation of success. The burden does not shift to Appellant until the Examiner makes out a *prima facie* case of obviousness. Appellant respectfully submits that in the present case the Examiner has not met this burden and therefore the burden does not shift to the Appellant to demonstrate how claims 1, 8, and 15 are patentable over *Tan* in view of *Assadi*. Thus Appellant respectfully submits that claims 1, 8, and 15 are patentable over *Tan* in view of *Assadi*.

Claims 2-3 and 6 properly depend from claim 1 and are thus patentable for at least the same reasons that claim 1 is patentable. Claims 9-10 and 13 properly depend from claim 8 and are thus patentable for at least the same reasons that claim 8 is patentable. Claims 16-18 properly depend from claim 15 and are thus patentable for at least the same reasons that claim 15 is patentable. (MPEP §2143.03 (citing *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988))). Accordingly, Appellant respectfully requests that the rejections to claims 1-3, 6, 8-10, 13, and 15-18 be overturned.

Rejection of Claims 4 and 11 Under 35 U.S.C. §103(a)

In the Office Action, the Examiner rejected claims 4 and 11 under 35 U.S.C. §103(a) as being obvious over *Tan* in view of *Assadi* in view of Appellant's allegedly admitted prior art.

Claim 4 properly depends from claim 1 and is thus patentable for at least the same reasons that claim 1 is patentable. Claim 11 properly depends from claim 8 and is thus

patentable for at least the same reasons that claim 8 is patentable. (MPEP §2143.03 (citing *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988))). Accordingly, Appellant respectfully requests that the rejections to claims 4 and 11 be overturned.

Rejection of Claims 5, 7, 12, 14, and 19 Under 35 U.S.C. §103(a)

In the Office Action, the Examiner rejected claims 5, 7, 12, 14, and 19 under 35 U.S.C. §103(a) as being obvious over *Tan* in view of *Assadi* in further view of view of U.S. Patent No. 5,396,090 to Nakai (hereinafter “*Nakai*”).

Claims 5 and 7 properly depend from claim 1 and are thus patentable for at least the same reasons that claim 1 is patentable. Claims 12 and 14 properly depend from claim 8 and are thus patentable for at least the same reasons that claim 8 is patentable. Claim 19 properly depends from claim 15 and is thus patentable for at least the same reasons that claim 15 is patentable. (MPEP §2143.03 (citing *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988))). Accordingly, Appellant respectfully requests that the rejections to claims 5, 7, 12, 14, and 19 be overturned.

CONCLUSION

Appellant respectfully submits that the Examiner has failed to set forth a *prima facie* case of obviousness with respect to the claimed invention. Appellant therefore respectfully submits that the rejections of the claims under appeal are improper and requests that the rejections be overturned.

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN

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/Elizabeth A. Garcia/

August 4, 2008

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Date

VIII. Claims Appendix

The pending claims as they stand on appeal are presented below.

1. (Previously Presented) An image sensor comprising:
a plurality of pixels formed in a semiconductor substrate, each pixel including a light sensitive element;
a micro-lens over each of said light sensitive elements; and
a raised ridge structure surrounding each of said micro-lenses, wherein said raised ridge structure has a triangular cross-section and at least partially supports said micro-lens, wherein the micro-lens overlays a base portion of the raised ridge structure.
2. (Original) The image sensor of Claim 1 wherein said raised ridge structure is circular.
3. (Previously Presented) The image sensor of Claim 1 wherein said raised ridge structure confines said micro-lens.
4. (Original) The image sensor of Claim 1 wherein the micro-lenses are formed from polymethylmethacrylate (PMMA) or polyglycidylmethacrylate (PGMA).
5. (Previously Presented) The image sensor of Claim 1 wherein said raised ridge structure has a height of about 0.2 microns.
6. (Original) The image sensor of Claim 1 wherein said raised ridge structure is formed from the same material that underlies said micro-lenses.
7. (Original) The image sensor of Claim 1 further including a color filter layer between said micro-lenses and said light sensitive elements.

8. (Previously Presented) A pixel of an image sensor comprising:
a light sensitive element formed in a semiconductor substrate;
a micro-lens over said light sensitive element; and
a raised ridge structure surrounding said micro-lens, wherein said raised ridge structure has a triangular cross-section and at least partially supports said micro-lens, wherein the micro-lens overlays a base portion of the raised ridge structure.
9. (Original) The pixel of Claim 8 wherein said raised ridge structure is circular.
10. (Previously Presented) The pixel of Claim 8 wherein said raised ridge structure confines said micro-lens.
11. (Original) The pixel of Claim 8 wherein the micro-lens is formed from polymethylmethacrylate (PMMA) of polyglycidylmethacrylate (PGMA).
12. (Previously Presented) The pixel of Claim 8 wherein said raised ridge structure has a height of about 0.2 microns.
13. (Original) The pixel of Claim 8 wherein said raised ridge structure is formed from the same material that underlies said micro-lenses.
14. (Original) The pixel of Claim 8 further including a color filter layer between said micro-lens and said light sensitive element.
15. (Previously Presented) A method of forming a pixel of an image sensor comprising:
forming a light sensitive element in a semiconductor substrate;
forming a top planarizing layer over said light sensitive element;
isotropically etching the top planarizing layer to form ~~forming~~ a raised structure over said top planarizing layer, said raised ridge structure encompassing said light sensitive element; and
forming a microlens within the interior of said raised ridge structure and over said light sensitive element, wherein said raised ridge structure has a triangular cross-section and at least

partially supports said micro-lens, wherein the micro-lens overlays a base portion of the raised ridge structure.

16. (Original) The method of Claim 15 wherein said raised ridge structure is formed in said top planarizing layer.

17. (Previously Presented) The method Claim 15 wherein said raised ridge structure confines said micro-lens.

18. (Original) The method of Claim 15 wherein said raised ridge structure is a closed shape.

19. (Original) The method of Claim 15 further including forming a color filter layer between said micro-lens and said light sensitive element.

IX. Evidence Appendix

Appellant makes no reference to evidence.

X. Related Proceedings Appendix

To the best of Appellant's knowledge, there are no prior or pending appeals, interferences, or judicial proceedings that may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.